National Aeronautics and Space Administration

Goddard Earth Science Data Information and Services Center (GES DISC)

README Document for

DMSP-OLS Stable Nighttime Lights Yearly Global 0.05Deg

DMSP-OLS Stable Nighttime Lights Yearly MAIRS Region 1km

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Revision History

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1.0 Introduction

This document provides basic information of the Nighttime Lights products from Defense Meteorological Satellite Program (DMSP) Operational Linescan System (OLS) in Giovanni system at NASA GES DISC.

The products are integrated into the Giovanni system for supporting regional environment and climate study associated with land cover/land use change over Monsoon Asia regions.

1.1 Dataset/Mission Instrument Description

The dataset in Giovanni are derived from the DMSP-OLS yearly Nighttime Lights version-4 time series, downloaded from NOAA National Geophysical Data Center (NGDC). The original data are collected by US Air Force Weather Agency and processed by NOAA NGDC.

DMSP satellites are in a sun-synchronous polar orbit, at altitude of 830km above the surface of the earth. DMSP-OLS consists of two telescopes and a photo multiplier tube (PMT). The visible telescope is sensitive to radiation from 0.40 - 1.10 um and 10-3 - 10-5 Watts per cm2 per sterradian. The infrared telescope is sensitive to radiation from 10.0 - 13.4 um and 190 to 310 Kelvins. The PMT is sensitive to radiation from 0.47 - 0.95 um and 10-5 - 10-9 Watts per cm2 per sterradian. OLS, with a 3000km swath, collected visible and near-Infrared emissions from the sun or the moon reflected off clouds and other features twice per day. Nighttime imagery has been used to detect city lights, manmade and natural fires, and natural gas flaring, etc.

The DMSP-OLS yearly Nighttime Lights version-4 time series are available since 1992 from six satellites. Two dataset are produced:

- **FnnNLGT_5km.004:** Stable Nighttime Lights Yearly Global 0.05Deg
- **FnnNLGT_MAIRS.004:** Stable Nighttime Lights Yearly MAIRS Region 1km

Where, Fnn is the satellite name (F10, F12, F14, F15, F16, and F18).

1.2 Algorithm

The DMSP-OLS yearly Nighttime Lights version-4 data are cloud-free composites made using all the available archived DMSP-OLS smooth resolution data for calendar years. In cases where two satellites were collecting data - two composites were produced. The products are 30 arc second

(0.0083333 degree) grids, spanning -180 to 180 degrees longitude and -65 to 75 degrees latitude.

Three image types are available as geotiffs at NOAA NGDC. The nighttime stable lights images are downloaded, which are the data files named as "FnnYYYY.v4b_web.stable_lights.avg_vis.tif". Where Fnn (F10, F12, F14, F15, F16, F18) is the satellite name and YYYY is year (1992, … 2010). The product is the cloud-free cleaned-up total number of observations, indicating the lights from cities, towns, and other sites with persistent lighting, including gas flares. Ephemeral events, such as fires have been discarded. Then the background noise was identified and replaced with values of zero. Data values range from 1-63. Areas with zero cloud-free observations are represented by the value 255.

Two datasets are created from the geotiff images for integrating into Giovanni system. One is global 0.05 degree (5.6 km at Equator), that averages all valid data values that went into each 0.05x0.05 degree grid cell. The other is 0.008333 degree (1km at Equator) over Asian Monsoon region, which is the spatial subset of the original data for the area (0^o – 60^oN, 60^oE – 150^oE). Both output datasets are in HDF-4 format.

1.3 Data Quality

As documented in the DMSP-OLS nighttime lights product Readme (http://www.ngdc.noaa.gov/dmsp/gcv4_readme.txt), a number of constraints are used to select the highest quality data for entry into the composites:

- Data are from the center half of the 3000 km wide OLS swaths. Lights in the center half have better geolocation, are smaller, and have more consistent radiometry.
- Sunlit data are excluded based on the solar elevation angle.
- Glare is excluded based on solar elevation angle.
- Moonlit data are excluded based on a calculation of lunar illuminance.
- Observations with clouds are excluded based on clouds identified with the OLS thermal band data and NCEP surface temperature grids.
- Lighting features from the aurora have been excluded in the northern hemisphere on an orbit-by-orbit manner using visual inspection.

In generating datasets for Giovanni use, the data quality of the input data is remained, no filtering is performed.

1.4 Data Disclaimer

The datasets are derived from DMSP-OLS yearly Nighttime Lights version-4 time series, downloaded from NOAA National Geophysical Data Center (NGDC). The data are not copyrighted and are open to all for both commercial and non-commercial uses. If you use the

data for a publication (research or otherwise), or for any other purpose, we request you to acknowledge data producer and to include the following acknowledgement:

"The data used in this effort were acquired from NASA Goddard Earth Sciences (GES) Data and Information Services Center (DISC)"

The data producer requires data users to use the following credit:

> Image and data is processed by NOAA's National Geophysical Data Center. DMSP data is collected by US Air Force Weather Agency.

We would appreciate receiving a copy of publication reference. Please email to gsfc-help-disc@lists.nasa.gov

2.0 Data Organization

Each data file contains gridded data that are composites of observations within each grid cell over an entire year period.

2.1 File Naming Convention

The files are named in accordance to the following convention:

FnnNLGT_5km.004: <Fnn>.stable_lights.<YYYY>.5km_avg.hdf

FnnNLGT_MAIRS.004: <Fnn>.stable_lights.<YYYY>.1km.MAIRS.hdf

Where:

<Fnn> = Satellite number

(F10, F12, F14, F15, F16, F18)

<YYYY> = year

File Example:

F10.stable_lights.1992.5km_avg.hdf (data from F10 for year 1992, resolution 0.05Deg)

F10.stable_lights.1992.1km.MAIRS.hdf (data from F10 for year 1992, resolution 1km)

2.2 File Format and Structure

Files are in Hierarchical Data Format (HDF) version-4 (HDF-4) format, developed at the National Center for Supercomputing Applications http://www.hdfgroup.org/.

2.3 Key Science Data Fields

One Science Data Fields in each data file:

stable_lights: Stable Nighttime Lights

Read section 3.3 for details.

3.0 Data Contents

3.1 Dimensions

FnnNLGT_5km.004:

YDim = 2800;
XDim = 7200;

FnnNLGT_MAIRS.004:

YDim: = 7201
XDim: = 10801 ;

3.2 Global Attributes

The Global attributes in the file contains basic information of the data file, such as Product name, data source, spatial coverage, etc. For example:

// global attributes:
:Product = "Nighttime Lights resolution 5km" ;
:Data_Source = "DMSP-OLS V4 Nighttime Lights (http://www.ngdc.noaa.gov/dmsp/downloadV4composites.html)" ;
:Processing_Method = "This product is generated from yearly DMSP-OLS V4 stable_lights.avg_vis nighttime light. The original 30 arc second grids (0.008333x0.008333), spanning -180 to 180 deg lon and -65 to 75 deg lat dataset has been regridded to 5kmx5km degree using box averaging method." ;
:Northernmost_Latitude = 75.f ;
:Southernmost_Latitude = -65.f ;
:Westernmost_Longitude = -180.f ;

:Easternmost_Longitude = 180.f ;
:First_Point_Latitude = 74.974998f ;

3.3 Products/Parameters

Both **FnnNLGT_5km.004 and FnnNLGT_MAIRS.004** data files contains one science data field (parameter) *as listed in the following table:*

Name	LongName	Unit	Data Type	Fill Value	Data Range
stable_lights	Stable Nighttime Lights	unitless	float	255	0-63

4.0 Options for Reading the Data

4.1 Command Line Utilities

4.1.1 ncdump

The ncdump tool can be used as a simple browser for HDF data files, to display the dimension names and sizes; variable names, types, and shapes; attribute names and values; and optionally, the values of data for all variables or selected variables in a netCDF file. The most common use of ncdump is with the –h option, in which only the header information is displayed.

ncdump [-c|-h] [-v ...] [[-b|-f] [c|f]] [-l len] [-n name] [-d n[,n]] filename

Options/Arguments:

[-c]	Coordinate variable data and header information
[-h]	Header information only, no data
[-v var1[,...]]	Data for variable(s) <var1>,... only data
[-f [c|f]]	Full annotations for C or Fortran indices in data
[-l len]	Line length maximum in data section (default 80)
[-n name]	Name for netCDF (default derived from file name)
[-d n[,n]]	Approximate floating-point values with less precision filename File name of input netCDF file

Note: the ncdump tool will only display variables whose ranks are great than 1. In other words, you will not see one dimensional vectors such as *satheight* using this tool.

The ncdump program can be found in bin directory of the HDF installation area. Consult your local computer system administrator for the specifics.

4.1.2 hdp

The hdp utility is a HDF dumper developed by HDF group at NCSA.

Usage: hdp [-H] command [command options] <filelist>

-H Display usage information about the specified command.

If no command is specified, -H lists all commands.

Commands:

list	ists contents of files in <filelist>
dumpsds	displays data of SDSs in <filelist>
dumpvd	displays data of vdatas in <filelist>.
dumpvg	displays data of vgroups in <filelist>.
dumprig	displays data of RIs in <filelist>.
dumpgr	displays data of RIs in <filelist>.

For more information, please visit the NCSA web site: http://hdf.ncsa.uiuc.edu/hdp.html

4.1.3 read_hdf

The read_hdf tool is a command-line utility developed by GES DISC. It allows a user to browse the file structure and display data values if desired.
Command line syntax:
read_hdf [-l] | [[-i | -d] [-a <output> | -b <base>.*.bin]] filename

Options/Arguments:

[-i] -- run in interactive mode (default), or
[-l] -- list a tree of file objects, or
[-d] -- dump all HDF object types (no filtering)
[-a <output>] -- ASCII output file name (default is <filename>.txt)
[-b <base>] -- base binary output file name (default is <filename>)
creates two files per HDF object:
<base>.*.met for metadata, and <base>.*.bin for binary data
(default output to stdout)
filename -- name of the input HDF file

The source code is written in C language and can be obtained from GES DISC ftp server:
ftp://disc1.gsfc.nasa.gov/software/aura/read_hdf

4.2 HDFView

The HDFView is a visual tool for browsing and editing NCSA HDF4 and HDF5 files. Using HDFView, you can:

(1) view a file hierarchy in a tree structure
(2) create new file, add or delete groups and datasets
(3) view and modify the content of a dataset
(4) add, delete and modify attributes
(5) replace I/O and GUI components such as table view, image view and metadata view

More information can be found at the official HDFView web site. There is an add-on plug-in for handling HDFEOS data specifically.

4.3 GrADS

The Grid Analysis and Display System (GrADS) is an interactive desktop tool developed and maintained by Institute of Global Environment and Society (IFES). GrADS supports many data file formats, including binary (stream or sequential), GRIB (version 1 and 2), NetCDF, HDF (version 4 and 5), and BUFR (for station data). Software download and more information and usages can be found at the GrADS web site: http://www.iges.org/grads/grads.html

To read the data by using GrADS, it needs to have a GrADS descriptor file that documents data source, structure, etc. For example, the following is the contents of a descriptor file, save it to a file “light.ctl”:

```
dset  ^F10.stable_lights.1992.5km_avg.hdf
options yrev
title "nightlight data"
dtype hdfsds
undef 255
xdef 7200  linear -179.975 0.05
ydef 2800  linear -64.975 0.05
zdef 1 levels 1000
tdef 30 linear  1Jan1992  1yr
vars 1
stable_lights=>data 0  y,x  Nightlight
endvars
```

The following is an example to read and plot an image by using GrADS:

```
'open light.ctl'
'set lon 118 122’
'set lat 29 33'
'set gxout shaded'
'set mpdset hires'
'set poli on'
```

'set clevs 5 10 15 20 25 30 35 40 45 50 55'
'd data'
'draw title DMSP-OLS Nighttime Lights'

5.0 Data Services

5.1 Access and analysis through Giovanni

Giovanni (GES DISC Interactive Online Visualization ANd aNalysis Infrastructure) is a Web-based application that provides a simple and intuitive way to visualize, analyze, and access data (Berrick, et al., 2009). The datasets have been integrated into the Giovanni system and are available through the Giovanni portal named mairs_yearly:

http://gdata1.sci.gsfc.nasa.gov/daac-bin/G3/gui.cgi?instance_id=mairs_yearly

Sample Images from Giovanni:

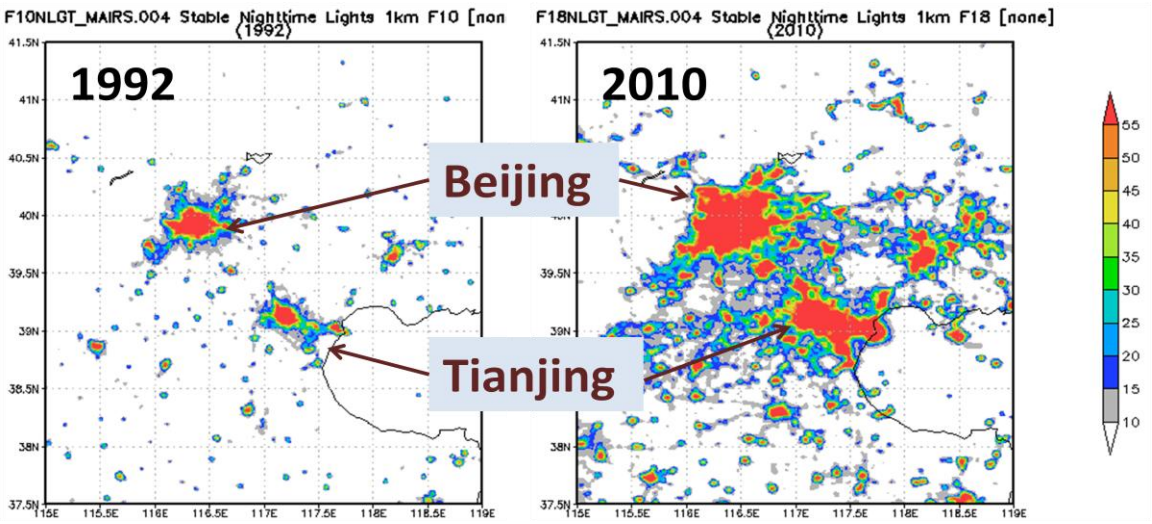

Figure: False-color images of nighttime lights from DMSP-OLS at 1km resolution for 1992 and 2010 over Beijing-Tainjing China. Images are generated from Giovanni. The area size of bright nighttime lights over Beijing and Tainjing are expended dramatically during about 20 years due to fast expending of cities.

Color palettes and more image display settings can be modified easily in Giovanni system. The data can be downloaded in ASCII, netCDF and HDF formats. More Giovanni portals can be found at http://disc.gsfc.nasa.gov/giovanni .

5.2 Direct FTP:

The data are available on anonymous FTP site:

ftp://neespi.gsfc.nasa.gov/data/s4pa/Nightlight

6.0 More Information

NOAA NGDC DMSP-OLS Nighttime Lights: http://www.ngdc.noaa.gov/dmsp/sensors/ols.html

Berrick, S., Leptoukh, G., Farley, J., & Rui, H. (2009). Giovanni: A Web services workflow-based data visualization and analysis system. *IEEE Trans. Geosci. Remote Sens*., *47*(1), 106-113.

Any question regarding data, please contact: help-disc@listserv.gsfc.nasa.gov.

7.0 Acknowledgements

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